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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In the Matter of

Amendment of Part 90 of the
Commission's Rules to Adopt
Regulations for Automatic
Vehicle Monitoring Systems

PR Docket No. 93-61

RM-8013

REPLY COMMENTS OF HUGHES AIRCRAFT COMPANY

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SUMMARY

Hughes Aircraft Company supports the Commission's proposal to limit the potential for harmful interference between different types of LMS systems by licensing them in separate bands within 902-928 MHz. In its comments in this proceeding, Hughes recommended that the Commission differentiate between types of LMS systems based on function and coverage area, with non-pulse-ranging, "local-area" systems authorized in the 902-904, 912-918 and 926-928 MHz bands. Hughes also proposed that the Commission establish radiated power and antenna height limits for such local-area systems, as a means to minimize risk of co-channel interference and facilitate informal coordination among licensees. These measures will also significantly reduce the chance of harmful interference between local-area LMS systems and other users of the band, such as Part 15 devices and amateurs. Several other commenters have made similar suggestions.

In these reply comments, Hughes joins other commenters in recommending a field strength limit, in conjunction with power/height limits, to give local-area system

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to Roadside Communications ("VRC"), described in greater detail at pages 3-5 of the Hughes Comments.

INTRODUCTION

In its comments, Hughes supported the Commission's proposal to license local- and wide-area LMS technologies in different portions of the 902-928 MHz frequency band. Hughes recommended that eligibility criteria for licensing in particular bands be based on geographic coverage area of the LMS system to be licensed, with so-called wide-area systems eligible for licensing at 904-912 and 918-926 MHz, and local-area systems at 902-904, 912-918 and 926-928 MHz. See Hughes Comments at 6-8. Hughes also suggested that, in order to reduce the potential for co-channel interference among adjacent licensees, local-area systems be subject to a combined radiated power/antenna height limit of 30 watts ERP and 15 meters, with power reduced at greater antenna heights. Id. at 7-9.

Hughes further recommended that: (1) the Commission's proposed frequency stability requirement for wide-area systems not apply to local-area systems, Id. at 13; (2) that, if 912-918 MHz proves to be unavailable for LMS use, that proposed

proposal, these recommended classifications divide LMS systems both functionally and by area covered. Although the choice of labels is relatively unimportant, Hughes strongly recommends adoption of such a channelization scheme for LMS. In these reply comments, to be consistent with its original comments, Hughes makes use of the terms "local-area" to denote non-pulse-ranging LMS systems proposed for licensing in the 902-904, 912-918 and 926-928 MHz bands, and "wide-area" for pulse-ranging systems proposed to be licensed in the 904-912 and 918-926 MHz bands.

wide-area spectrum be allocated to local-area use, Id. at 13-14;^{2/} (3) that warning labels not be required for local-area systems due to the reduced threat of interference, Id. at 14-15; (4) that the eight-month construction period be retained, Id. at 15; and (5) that mobile transponders, or "tags," used in LMS systems be covered by licenses for base stations, so long as such tags can transmit only when interrogated by corresponding base stations, Id. at 15-16.

The comments filed in response to the NPRM fall into several distinct categories, based on the nature of the commenters' interests in allocation of the 902-928 MHz band. These interests can be broken down as follows: local-area LMS systems (including Hughes); wide-area LMS systems; unlicensed devices operating under Part 15 of the Commission's rules; and amateur radio.^{3/} Most of the Part 15 and amateur radio commenters expressed concern that the Commission's proposals to open up the entire

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2. The American Radio Relay League, Incorporated ("ARRL"), claims that, because the interim rules governing AVM did not authorize use of the entire 902-928 MHz band, and because Teletrac did not petition for use of the entire band, the Commission's actions to add the 902-903, 912-918 and 927-928 MHz bands to the spectrum available for LMS "appears gratuitous, and without justification." ARRL Comments at 5-6. See also 47 C.F.R. § 90.239. This ignores the words of the Commission, which recognized that, due to the potential for co-channel interference between local- and wide-area systems, it is necessary to license these LMS uses in different bands. See NPRM at 2504. Moreover, recent growth in the numbers and types of LMS systems have rendered the interim rules obsolete, and brought about the need to create a new regulatory and channelization scheme that "provide[s] a competitive and dependable environment in which [LMS] systems can continue to develop." Id. at 2504. Finally, ARRL appears to have overlooked the fact, discussed more fully in these reply comments, that local-area LMS operations pose significantly less potential for interference with other users of the band than do wide-area systems.
 3. In addition to these, comments were filed by Radian Corporation ("Radian"), manufacturer of wind profiler radar systems. Radian has filed a petition for rulemaking, seeking allocation of 908.75-921.25 MHz for wind profiler systems. A Notice of Inquiry regarding Radian's petition is pending before the Commission. See Wind Profile Radar Systems, Notice of Proposed Rulemaking and Notice of Inquiry, 8 FCC Rcd. 2546 (April 1, 1993). The Commission has stated that the wind profiler proceeding will consider decisions made in this proceeding. NPRM at 2505 n. 33. Hughes has filed comments and reply comments in the wind profiler proceeding, and does not address Radian's comments here.

912-918 MHz band to, and expand the definition of, LMS would lead to increased harmful interference with secondary uses of the band. Hughes submits that such need not be the case, at least with regard to local-area LMS systems. The antenna height/radiated power restrictions proposed by Hughes, and other commenters, for local-area systems operating in the 902-904, 912-918 and 926-928 MHz bands will allow successful sharing of these bands among LMS systems and with other authorized users. Below, Hughes addresses certain comments of other interested parties.

DISCUSSION

I. Local-Area Issues

A number of commenters expressed concern that expanded licensing of LMS systems in the 902-928 MHz band would increase harmful interference with Part 15 devices. Hughes notes that most of these addressed the risks posed by wide-area systems, such as that of Teletrac, and did not focus on local-area systems as significant sources of interference. See, e.g., Part 15 Coalition Comments at 10-11 (noting that the Teletrac Petition makes clear the "fragility of the Teletrac system"); Metricom Comments at 4-8 (discussing "Teletrac's admittedly fragile system architecture," Id. at 5);

Telecommunications Industry Association Mobile and Personal Consumer Radio Section

Comments at 2 (noting that wide-bandwidth systems are particularly susceptible

While Hughes, as a developer of local-area LMS products, does not comment on the compatibility of wide-area systems with Part 15 devices, it concurs with the view, implicit in the above comments, that the risk of harmful interference between Part 15 devices and local-area systems is much smaller than with wide-area systems. Local-area LMS operators are better able to coordinate informally with other users of the same spectrum, because they have greater flexibility with regard to signal characteristics. See Metricom Comments at 22 ("the existing sharing arrangement has worked well and permitted operations in the band by a multitude of users, licensed and unlicensed . . . [that] have worked together to solve interference problems in the past"). In addition, compatibility of local-area systems with other uses of the band will be greatly enhanced by adopting certain technical requirements for local-area systems, proposed in the Hughes Comments, and discussed below.

A. Power/Height Limitation

In line with Hughes' proposal to segregate LMS systems by the size of the area effectively covered by their radiated signal, Hughes proposed that local-area systems be limited to 30 watts ERP at an antenna height of up to 15 meters, and that the upper limit on radiated power be reduced with increased antenna height. See Hughes Comments at 7-10. A number of other commenters on the NPRM agreed that height/power restrictions for local-area systems would significantly improve spectrum efficiency without compromising performance. See, e.g., Amtech Comments at 17 (30 watts ERP at 10 meters); Mark IV Comments at 13 (maximum antenna height of 10 meters and field strength limited to 1 mV/m measured at 3000 yards from the

transmitter); AT&T Comments at 7-8 (30 watts and 10 meters, maximum); Saab-Scania Combitech AB Comments at 18-19 (20 watts and 30 feet, maximum).

Several commenters proposed alternatives to height and power limitations, for use in unusual circumstances. Hughes agrees with the concept proposed by Amtech and Mark IV: limiting field strength at a certain distance. See Amtech Comments at 17 n. 33; Mark IV Comments at 13. Such an approach maximizes flexibility while still minimizing the chance of harmful interference among local-area systems. A limitation of field strength at a set distance allows local-area users to use increased power where terrain or other features will block the signal, and to use greater antenna heights so long as the antenna pattern minimizes signal strength toward other co-channel systems.

Hughes favors the proposal of Mark IV for a local-area field strength limit of 1 mV/m at 3000 meters. Mark IV Comments at 13. This specification is approximately 22 dB below the free space value for 30 watt ERP, proposed as a power limit by Hughes. Amtech, on the other hand, proposes a limit of 33 dB(mV/m) at one-half mile. Amtech Comments at 17 n. 33. This is equal to the free space value for a 30 watt ERP. The Amtech proposal thus would effectively negate the utility of the height limit. The antenna height restriction takes into account the fact that most of the time the path between a local-area system and its neighboring system will be obstructed. Therefore, the power level of the interfering signal will usually be significantly below free space. By simply using the free space value in the proposed rule, as proposed by Amtech, the local-area system can either raise its antenna until the path is no longer obstructed or increase power to the point where the effect of the obstructed path is

negated. Neither of these alternatives will promote sharing between co-channel local-area systems.

The field strength limit discussed above could serve as the single means of regulating local-area coverage, without the need for antenna height/ERP limits.

However, Hughes believes that the vast majority of local-area systems will operate well within the proposed height/power limits. By defining these parameters as part of the rule, the Commission will provide a clear-cut means of ensuring that most local-area systems are compliant. In situations where either the height or power limit is insufficient to meet minimum system performance, local-area systems could be designed to exceed height/power limits, so long as license applications include analyses sufficient to show compliance with field strength limits. Hughes therefore proposes adoption of the following limitations on local-area systems: (1) ERP limited to 30 watts and antenna height limited to 10 meters;^{4/} or (2) field strength no greater than 1 mV/m at 3000 meters.

Amtech also proposes an ERP limit of 100 watts in the 902-906 and 924-928 MHz bands for "highway beacons." Amtech Comments at 18. To the extent that 100 watt ERP highway beacons can meet the field strength limitation discussed above, Hughes has no objection to such a proposal. However, Hughes does not believe it is necessary or desirable to allow local-area systems to have ERPs above 30 watts in cases where this would lead to increased risk of interference to adjacent systems. Hughes also

4. Although it originally proposed a maximum antenna height of 15 meters, Hughes agrees with the other commenters cited above that 10 meters height above ground will be sufficient for the vast majority of local-area services. Accordingly, Hughes adopts the 10 meter limit here.

notes that its VRC system requires only a 4 Watt ERP to effectively link with all passing vehicles on a high speed, multi-lane highway.

B. Co-Channel Separation Distances

Mark IV proposes that new local-area systems maintain two miles of separation from existing local-area systems. Mark IV Comments at 9, 13. Such a requirement should be unnecessary, however. By implementing the power/height and field strength restrictions proposed above, the Commission can ensure that local-area systems are capable of virtually interference-free operation without a quantitative separation requirement, especially in light of good faith cooperation between licensees. Should the Commission decide, on the other hand, that power/height and field strength limits alone do not sufficiently guarantee protection from interference, Hughes recommends adoption of a proven coordination process rather than geographic separation. Mandatory geographic separation between local-area facilities will unnecessarily restrict the number of services that can be provided to the public in a given area.

C. Frequency Stability

In the NPRM, the Commission proposed a frequency stability requirement of five parts per million, or 0.0005%, for wide-area systems, and requested comment on whether any stability requirement was needed for local-area systems. Hughes noted that, even for wide-area systems, such strict frequency stability would yield little improvement in spectrum efficiency. Hughes Comments at 13. Hughes also pointed out that it makes

no sense to impose this requirement on local-area systems, especially wide-band local-area systems that will use 912-918 MHz. Id.

Teletrac proposes to require all LMS systems to meet a frequency stability standard of 2.5 parts per million, or 0.00025%, half that proposed for wide area systems in the NPRM. See Teletrac Comments at 49. Teletrac asserts that wide-area systems need to control frequency tolerances even more closely than contemplated by the NPRM to accurately calculate signal time of arrival. Id. Thus, because pulse-ranging systems must meet very strict frequency stability requirements just to function effectively, meeting the tolerance proposed in the NPRM entails little or no additional design effort or costs for such systems.

Teletrac goes on to hypothesize that "narrowband" systems "will have an incentive to locate close to the band edges, which suggests that they will employ strict frequency control." Id. (emphasis added). At least with regard to Hughes' VRC technology, Teletrac's assumption regarding proximity to the band edges is inaccurate. Absent some indication that particular local-area systems require strict frequency tolerances to operate effectively, there is no logical reason to impose such a potentially costly requirement on local-area licensees.

Teletrac states that, while its proposal is more exacting than that in the NPRM, it is less stringent than that imposed on 900 MHz land mobile radios (0.1 part

results in a total frequency uncertainty of 187 Hz (at 935 MHz) in the 12.5 kHz channel, i.e. 1.5% of the bandwidth. The Teletrac proposal of 2.5 parts per million would allow a frequency uncertainty of 4.5 kHz, but this is only 0.07% of the 6 MHz local-area channel, or less than 5% of the amount of variation allowed in land mobile services. Considering that a 900 MHz land mobile base station can cover an entire metropolitan area while a local-area transmitter might be less than one mile from a co-channel station, such extreme tolerances are not worth the cost to achieve them.^{5/} The Commission should not adopt Teletrac's proposal with regard to local-area LMS systems.

D. Narrow-Band Pulse-Ranging

The NPRM proposed that narrowband (less than or equal to 2 MHz) wide-area pulse-ranging systems be licensed at 902-904, 912-918 and 926-928 MHz, the same bands as local-area systems. NPRM at 2505. Hughes stated that it was unaware of any such systems being proposed, and did not expect that any would be developed. Hughes Comments at 10.^{6/} It initially appears from the comments, however, that Southwestern Bell Mobility Systems ("SBMS") may be proposing a 2 MHz (i.e. narrowband) wide-area system. See SBMS Comments at 7. SBMS states that the system it intends to establish in Chicago can perform wide-area location functions "within 2 MHz of spectrum." Id. Later in its comments, however, SBMS reveals that its system operates using "a 2 MHz null-to-null bandwidth." Id. at 14 n. 28. The null-to-null bandwidth is not a practical

5. Although not addressed by Teletrac, it would be even less appropriate to apply any frequency stability requirement upon mobile tags, which operate at power significantly below 1 watt.

6. Hughes went on to propose that if narrowband pulse-ranging systems appeared, they should be licensed in the two wide-area channels (904-912 or 918-926 MHz), or, if necessary, in one of the two narrowband local area channels (902-904 or 926-928 MHz). Id.

definition of bandwidth for regulatory purposes and is a much smaller number than either the "occupied bandwidth" or "necessary bandwidth" defined in Sections 2.202(a) & (b) of the Commission's rules.^{7/} This is confirmed by the fact that both SBMS's Recommended Allocation (SBMS Comments at 10) and its Alternative Allocation (SBMS Comments Exhibit A), which require 4 megahertz. Thus, SBMS is not really proposing a narrowband pulse-ranging system and no comments filed in response to the NPRM support the need for such systems.

II. Other Technical Issues

A. Edge-of-Channel Suppression Requirements

The Commission proposed a suppression requirement outside the authorized channel of $55 + 10\log(P)$ dB (where P is the transmitter power in watts). NPRM at 2508. Several commenters have addressed this requirement. For example, Mark IV and Teletrac proposed using the Commission's attenuation formula outside the 902-928 MHz band, but adopting a less stringent requirement within the band. Mark IV proposed a suppression requirement of $30 + 10\log(P)$ dB for emissions within the band. Mark IV Comments at 12. Teletrac, along with an express requirement to not cause interference, proposed a requirement that, within the 902-928 MHz band, 99% of the energy be within the authorized channel. Teletrac Comments at 50. Mobilevision suggests that, because peak power measurements of spread spectrum signals depend on the measurement bandwidth, the Commission should consider using an attenuation

7. While SBMS did not provide sufficient technical details regarding its system to fully analyze power levels, Hughes notes that, with a classical $(\sin x)/x$ power distribution, the first sidelobe is only 13 dB down, but yet would still be outside the null-to-null bandwidth.

requirement with the peak power stated in watts-per-hertz. Mobilevision Comments at Technical Appendix p. 18. In that case, maximum allowable emissions would be expressed as $-(100 + 10\log(P))$ dBW/Hz. Id.

Hughes believes that the Commission intended the proposed $55 + 10\log(P)$ dB standard to prevent adjacent channel interference both to services outside the 902-928 MHz and between local- and wide-area LMS services within the band. Hughes supports the Commission's proposal, and recommends that the $55 + 10\log(P)$ dB requirement be retained.^{8/} If the Commission were to accept any relaxation of this standard, Hughes recommends a careful review of the Mobilevision proposal. That proposal yields the equivalent of a 5 dB relaxation of the $55 + 10\log(P)$ dB limit, when power is measured in a 100 kHz bandwidth.^{9/} Hughes believes this is preferable to the Mark IV proposal, which would result in relaxation of the NPRM attenuation requirement by 25 dB.

B. Wide-Area Power Limitation

Amtech, at page 33 of its comments, and Pinpoint Communications, Inc., at page 32 of its comments, both support extremely high power limits on wide-area systems. These proposals are of concern because neither Amtech nor Pinpoint propose any separation by channel of the wide- and local-area systems. For base stations, both of these commenters propose a 5 kilowatt ERP limit, with no limitation on antenna height.

8. Hughes also noted that it was appropriate for the $10\log(P)$ dB term to actually be negative for transmitter powers below 1 watt. Hughes Comments at 12 n. 9. The $55 + 10\log(p)$ or $30 + 10\log(P)$ formulas provide a constant level of protection across all transmitter power levels.

9. Mobilevision stated that its proposal would be equivalent to $55 + 10\log(P)$ dB in a 30 kHz bandwidth. Id.

For mobiles, the proposed ERP limit is 50 watts. While Amtech proposes a power density limit (albeit a high one of 625 W/MHz) in addition to the total limit on ERP, Pinpoint proposes no such limit. If the Commission were to adopt both proposals -- no channel separation between wide- and local-area systems and high power levels -- it would need to impose the requirement that new applicants formally coordinate their systems with existing licensees. Hughes recommends that the Commission retain the channelization plan for wide- and local-area LMS activities proposed in the NPRM, regardless of power limits.

C. Tag Duty Cycle

Amtech proposes that tags used in wide-area LMS systems be limited to transmitting no more than 10 milliseconds in any 100 milliseconds. Amtech Comments at 33. Hughes supports this proposal, and believes that it would not significantly interfere with wide-area operations while reducing the potential for interference between wide- and local-area systems. While a tag duty cycle limit would be useful if the Commission adopts proposed rules that assign different channels within 902-928 MHz to wide- and local-area systems, Hughes believes that such a regime would become essential to

effecting local-area operations if the Commission adopts an alternative scheme that

CONCLUSION

Hughes' recommendations for regulating LMS services, such as designating services and assigning channels by area covered and imposing height/power limits on local-area services, have been echoed in a number of the comments filed in response to the NPRM. Moreover, many of the concerns about potential for interference raised by established users of the 902-928 MHz band will be avoided by adopting measures, proposed by Hughes, to reduce the risk of interference, at least with regard to local-area LMS systems. Hughes urges the Commission to move quickly to adopt rules governing LMS, modified as described above, so that the many products already developed or being developed can be deployed without uncertainty regarding frequency allocation or risk of interference.

Respectfully submitted,

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